CLAIMS

What is claimed is:

1. A flat electrical cable comprising:

an upper insulator layer;

a lower insulator layer connected to the upper layer along substantially continuous parallel spaced apart seams; and

an intermediate layer comprised of individual strands of conductors which lie adjacent and substantially parallel to the seams, and the conductors do not have an adhesive residue thereon, wherein seams positioned between adjacent conductors have a textured surface pattern, and wherein seams positioned along edges of the flat electrical cable have a substantially smooth surface pattern.

2. The flat electrical cable of Claim 1 wherein the upper layer includes a plurality of raised surfaces running parallel to each other along the length of the flat cable.

3. The flat electrical cable of Claim 1 wherein the upper and lower insulator layers are polyester.

4. The flat electrical cable of Claim 1 wherein the conductors are made of at least one of a copper material and a copper alloy.

5. The flat electrical cable of Claim 1 wherein at least one of the conductors is a fiber optic cable.

6. The flat electrical cable of Claim 1 wherein at least one of the seams is ultrasonically welded.

7. The flat electrical cable of Claim 6 wherein the at least one of the seams is positioned

along an edge of the flat electrical cable and is broader than at least one of the seams positioned between adjacent conductors.

8. The flat electrical cable of Claim 7 wherein the at least one of the seams being positioned along an edge of the flat electrical cable is produced by a broad protrusion on an ultrasonic welding anvil.

9. The flat electrical cable of Claim 6 wherein at least one of said seams being positioned along an edge of the flat electrical cable is cut so as to form a smooth edge thereon.

10. The flat electrical cable of Claim 1 wherein seams positioned along edges of the flat electrical cable are broader than seams positioned between adjacent conductors.

11. The flat electrical cable of Claim 1 wherein seams positioned along edges of the flat electrical cable are cut so as to form a smooth edge thereon.

12. The flat electrical cable of Claim 1 wherein the conductors are exposed at an end portion of the flat cable beyond the upper and lower insulator layers.

13. The flat electrical cable of Claim 1 wherein the cable includes a continuous seam except for a nonbonded area where the upper and lower insulator layers are not connected.

14. The flat electrical cable of Claim 1 wherein the cable includes a continuous seam except for a nonbonded area where the upper and lower insulator layers include windows that expose the conductors.

15. The flat electrical cable of Claim 1 wherein seams positioned between adjacent conductors have a knurled textured surface pattern.

16. The flat electrical cable of Claim 3 wherein the conductors include seven conductors.

17. The flat electrical cable of Claim 16 wherein the flat electrical cable has a linear density

of substantially 4.35 grams per foot.

18. A flat electrical cable comprising:

an upper layer of polyester having a ribbed surface;

a lower layer of polyester connected to the upper layer along substantially continuous parallel spaced apart ultrasonically bonded seams; and

individual strands of copper conductors lying substantially parallel and adjacent to the seams between the upper and lower layers, and wherein seams positioned between adjacent conductors have a textured surface pattern, and wherein seams positioned along edges of the flat electrical cable have a substantially smooth surface pattern.

19. The flat electrical cable of Claim 18 wherein seams positioned between adjacent conductors have a knurled textured surface pattern.

20. The flat electrical cable of Claim 18 wherein seams positioned between adjacent conductors have a repeating linear segment textured surface pattern, wherein the repeating linear segments are substantially perpendicular to a length of the flat electrical cable.

21. A flat electrical cable comprising:

an upper layer of polyester having a ribbed surface;

a lower layer of polyester connected to the upper layer along substantially continuous parallel spaced apart ultrasonically bonded seams; and

individual strands of copper conductors lying substantially parallel and adjacent to the seams between the upper and lower layers, and wherein seams positioned between adjacent conductors have a textured surface pattern, and wherein seams positioned along edges of the flat electrical cable have a first zone and a second zone, and wherein

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the first zone is adjacent to one conductor of the conductors and extends substantially parallel to the one conductor, and the first zone having a knurled textured surface pattern, and wherein

the second zone is located between the first zone and one edge of the edges, and the second zone having a smooth textured surface pattern.

22. A flat cable comprising:

an upper insulator layer;

a lower insulator layer connected to the upper insulator layer along substantially continuous parallel spaced apart seams; and

an intermediate layer comprised of conductor groups which lie adjacent and substantially parallel to the seams, and wherein the conductor groups do not have an adhesive residue thereon.

23. The flat cable of Claim 22 wherein one of the conductor groups includes a single conductor.

24. The flat cable of Claim 22 wherein one of the conductor groups includes an optical fiber.

25. The flat cable of Claim 22 wherein one of the conductor groups includes a tandem conductor group, wherein the tandem conductor group includes two substantially identical conductors positioned adjacent to each other.

26. The flat cable of Claim 22 wherein one of the conductor groups includes a dual stacked conductor group, wherein the dual stacked conductor group includes two substantially identical conductors, wherein a first conductor of the two substantially identical conductors is stacked on a second conductor of the two substantially identical conductors of the dual stacked conductor group.

27. The flat cable of Claim 22 wherein one of the conductor groups includes a triple stacked conductor group, wherein the triple stacked conductor group includes three substantially identical conductors, wherein a first conductor of the three substantially identical conductors is positioned adjacent to a second conductor of the three substantially identical conductors of the triple stacked conductor group, and wherein the second conductor of the three substantially identical conductors is positioned adjacent to a third conductor of the three substantially identical conductors of the triple stacked conductor group.

28. The flat cable of Claim 22 wherein one of the conductor groups includes a wire rope conductor group, wherein the wire rope conductor group includes a plurality of wire conductors wound together.

29. The flat cable of Claim 25 wherein another of the conductor groups includes a wire rope conductor group, wherein the wire rope conductor group includes a plurality of wire conductors wound together.

30. A flat electrical cable comprising:

an upper insulator layer;

a lower insulator layer connected to the upper layer along substantially continuous parallel spaced apart seams; and

an intermediate layer comprised of individual strands of conductors which lie adjacent and substantially parallel to the seams, and the conductors do not have an adhesive residue thereon, wherein seams positioned between adjacent conductors have a first textured surface pattern, and wherein seams positioned along edges of the flat electrical cable have a second surface pattern, and wherein a surface roughness of the first textured surface pattern is greater than a surface roughness

of the second textured surface pattern.

31. A clockspring for electrically connecting an airbag of a vehicle to crash sensors, the clockspring comprising:

a housing having an inner chamber; and

a flat electrical cable including an upper insulator layer; a lower insulator layer connected to the upper layer along substantially continuous parallel spaced-apart seams; and an intermediate layer comprised of individual strands of conductors which lie adjacent and substantially parallel to the seams and the conductors do not have an adhesive residue thereon, the flat electrical cable being mounted in the chamber of the clockspring, and wherein seams positioned between adjacent conductors have a textured surface pattern, and wherein seams positioned along edges of the flat electrical cable have a substantially smooth surface pattern.

32. The clockspring of Claim 31 wherein seams positioned between adjacent conductors have a knurled textured surface pattern.

33. The clockspring of Claim 31 wherein the upper layer includes a plurality of raised surfaces running parallel to each other along the length of the flat cable.

34. The clockspring of Claim 31 wherein the upper and lower insulator layers are polyester.

35. The clockspring of Claim 31 wherein the conductors are copper.

36. The clockspring of Claim 31 wherein at least one of the conductors is a fiber optic cable.

37. The clockspring of Claim 31 wherein the seams are ultrasonically welded.

38. The clockspring of Claim 31 wherein the conductors are exposed at an end portion of the flat cable beyond the upper and lower insulator layers.

39. The clockspring of Claim 31 wherein the cable includes a continuous seam except for a nonbonded area where the upper and lower insulator layers are not connected.

40. The clockspring of Claim 31 wherein the cable includes a continuous seam except for a nonbonded area where the upper and lower insulator layers include windows that expose the conductors.

41. The clockspring of Claim 31 wherein the upper and lower insulator layers are polyester, and wherein the upper insulator layer has a ribbed surface, and wherein the individual strands of conductors are copper, and wherein the substantially continuous parallel spaced-apart seams are ultrasonically welded.

42. The clockspring of Claim 31 wherein seams positioned along edges of the flat electrical cable are broader than seams positioned between adjacent conductors.

43. The clockspring of Claim 41 wherein seams positioned along edges of the flat electrical cable are produced by a broad protrusion on an ultrasonic welding anvil.

44. The clockspring of Claim 43 wherein seams positioned along edges of the flat electrical cable are cut so as to form a smooth edge thereon.

45. The clockspring of Claim 43 wherein seams positioned along edges of the flat electrical cable are broader than seams positioned between adjacent conductors.

46. The clockspring of Claim 45 wherein seams positioned along edges of the flat electrical cable are cut so as to form a smooth edge thereon.

47. A modular rotary anvil for mounting on an ultrasonic welding machine, the modular rotary anvil comprising:

a first end segment configured to attach to the ultrasonic welding machine;

a second end segment configured to attach to the ultrasonic welding machine; and

at least one insert having a first side and a second side, each of the first side and the second side configured to attach to at least one of other inserts, the first end segment, and the second end segment.

48. The modular rotary anvil as recited in Claim 47 wherein the at least one insert has a textured surface pattern.

49. The modular rotary anvil as recited in Claim 48 wherein the textured surface pattern is a knurled surface pattern.

50. The modular rotary anvil as recited in Claim 47 wherein the at least one insert has a flat, smooth surface pattern.

51. The modular rotary anvil as recited in Claim 47 wherein the at least one insert has a cutting surface.

52. The modular rotary anvil as recited in Claim 47 wherein the at least one insert has at least one recessed groove.

53. The modular rotary anvil as recited in Claim 52 wherein the at least one insert has a cutting surface.

54. The modular rotary anvil as recited in Claim 47 wherein the at least one insert has at least one protrusion.

55. The modular rotary anvil as recited in Claim 54 wherein the at least one protrusion extends around a circumference of the at least one insert.

56. The modular rotary anvil as recited in Claim 55 wherein the at least one protrusion has a flat, smooth surface texture pattern.

57. The modular rotary anvil as recited in Claim 55 wherein the at least one protrusion has a textured surface pattern.

58. The modular rotary anvil as recited in Claim 57 wherein the textured surface pattern is a knurled surface pattern.

59. The modular rotary anvil as recited in Claim 52 wherein the at least one recessed groove extends around a circumference of the at least one insert.

60. The modular rotary anvil as recited in Claim 59 wherein the at least one recessed groove has a flat, smooth surface textured pattern.

61. A method of assembling a flat electrical cable comprising the steps of:

simultaneously feeding an upper and lower layer of insulating material and an intermediate layer of conductors between a horn and a modular rotary anvil; and

ultrasonically bonding the upper and lower layers together along a seam substantially parallel and adjacent the conductors.

62. The method of Claim 61 wherein the step of ultrasonically bonding includes the horn operating in a plunge mode.

63. The method of Claim 61 wherein the step of simultaneously feeding includes the modular rotary anvil having at least one segment having a series of grooves and protrusions corresponding to the arrangement of the conductors oriented between the insulator layers wherein the insulator layers are compressed between the protruding portion and a weld surface of the rotary horn in order to form the seams.

64. The method of Claim 63 wherein at least one of the protrusions of the modular rotary anvil has a textured surface pattern.

65. The method of Claim 64 wherein the textured surface pattern is a knurled surface pattern.

66. The method of Claim 63 wherein at least one of the protrusions of the modular rotary anvil has a smooth surface pattern.

67. The method of Claim 61, further comprising the steps of cutting the flat cable into individual lengths and stripping ends of the flat cable.

68. The method of Claim 67 wherein the step of stripping includes the sub-steps of removing the upper and lower insulator layers so as to leave the conductors exposed and protruding beyond the end of the flat cable.

69. The method of Claim 67 wherein the step of stripping includes the sub-step of inserting the end of the flat cable into a rotary grinding machine to remove the upper and lower insulator layers to expose a width of the conductors, and removing the excess end portion of the cable to leave the protruding conductors.

70. The method of Claim 61, further comprising the step of testing the assembled flat cable for the presence of bonded seams.

71. The method of Claim 61 wherein the step of simultaneously feeding the intermediate layer of conductors includes at least one conductor which is a fiber optic cable.

72. A method of assembling a clockspring comprising the steps of:

making a flat cable including the sub-steps of simultaneously feeding an upper and lower layer of insulating material and an intermediate layer of conductors between a horn and a modular rotary anvil, and ultrasonically bonding the upper and lower layers together along a seam substantially parallel and adjacent the conductors; and

inserting the flat cable into a housing.

73. The method of Claim 72 wherein the sub-step of ultrasonically bonding includes the horn operating in a plunge mode.

74. The method of Claim 72 wherein the sub-step of simultaneously feeding the intermediate layer of conductors includes at least one conductor which is a fiber optic cable.

75. The method of Claim 74 wherein the sub-step of simultaneously feeding includes the modular rotary anvil having at least one segment having a series of grooves and protrusions corresponding to the arrangement of the conductors oriented between the insulator layers wherein the insulator layers are compressed between the protruding portion and a weld surface of the rotary horn in order to form the seams.

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76. The method of Claim 75 wherein at least one of the protrusions of the modular rotary anvil has a textured surface pattern.

77. The method of Claim 76 wherein the textured surface pattern is a knurled surface pattern.

78. The method of Claim 75 wherein at least one of the protrusions of the modular rotary anvil has a smooth surface pattern.

79. The method of Claim 72, further comprising the step of stripping a first end of the flat cable so as to expose the conductors, and further comprising the step of attaching an electrical connector to the first end of the flat cable, and wherein the electrical connector is mounted to the housing, and wherein the step of attaching immediately follows the step of stripping.

both attaching and mounting done by soldering - see disclosure pages 20 and 22.

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